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ABSTRACT

It is argued that the three basic issues that have typically been the concern of formative evaluation (comprehensibility, appeal, and usefulness) tell us very little about the role that an instructional product can play in the ongoing environment of the classroom. The focus in this paper is on the field test, i.e., on research situated within the framework of existing classroom activity. Four issues considered central to situated research are discussed: (1) How is the instructional prototype interpreted by teachers? (2) How does the prototype function as part of the ongoing content curriculum that is both the backbone and blueprint for classroom goals and activities? (3) How does the prototype function within the organizational context of the classroom? and (4) Within the social context of the classroom, how is the prototype interpreted by students? Each of these questions is addressed using examples from formative research with two different prototype products: a computer-based set of interactive cognitive tools to support inquiry practices in science ("Inquire"), and a television series that uses a narrative format to introduce students to different arenas of scientific and mathematical inquiry ("The Second Voyage of the Mimi"). (8 references) (GL)

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Challenges of Formative Testing: Conducting Situated Research in Classrooms

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Tech. Rep. No. 48

CHALLENGES OF FORMATIVE TESTING: CONDUCTING SITUATED RESEARCH IN CLASSROOMS

Jan Hawkins and Margaret Honey

In the development of educational technologies, formative research has been concerned with addressing three basic issues: (1) comprehensibility, (2) appeal, and (3) usefulness (Honey, 1987). Comprehensibility research investigates both the clarity of the educational ideas contained within the environment and, in the case of information technologies, the clarity of the interface that enables the user to interact with the program. Appeal research addresses the popularity of the basic activity among the target audience, and usefulness research evaluates the educational effectiveness of the product. Although these three elements constitute the objectives of formative research, they tell us very little about the actual role that the product can play in the ongoing environment of the classroom.

This paper focuses on a different and, we believe, an increasingly important category of formative research for interactive technologies in education—the field test, that is, research situated within the framework of existing classroom activity. Due to the time and resource constraints inherent in almost all development projects, researchers often have no choice but to examine apart from the classroom setting how students understand, are excited by, and learn from educational technologies. However, if the product is intended for use in a classroom setting, then it becomes imperative to examine how it functions within the complex environment of the classroom.

This belief derives from a framework which asserts that interactive technologies can play an important role in qualitatively improving learning and teaching *only* if these products are deeply integrated into the learning setting (Hawkins, Brunner, Ghitman, Mann, Magzamen, & Moeller, 1988; Honey, Martin, & Robinson, 1987; Rubin & Bruce, 1986). We have in mind products that do not take over or replace the curriculum, but are truly integrated into and enhance an array of possible learning activities. Such products make use of the power of interactive technologies to extend what it is possible to do, and thus can refashion the classroom situation (Lampert, 1985; Martin, 1987). To do this, formative information about how prototype products function in these social and intellectual contexts is needed.

In the initial phases of formative research, the testing is generally carried out with individual children or with small groups of children outside the classroom environment. This phase of the formative process is necessary to get a fine-grained reading of what features of the product are educationally effective and appealing to students, and what aspects of the product facilitate or deter students' interactions with it. This phase of research can also be used to solicit interview-type information from other relevant participants such as teachers and educational consultants. While useful to the designers and developers of educational technology this formative information can be at best only a very rough pass at how things will *really* work. Situated research serves a different purpose. It is important not simply as a final check to "polish" the details of a product, but it is critical to a problem that many schools and researchers are now defining: how to effectively *integrate* technologies into teaching and learning (e.g., Collins & Hawkins, 1989; Martin, 1988).

Situated research allows us to address different

A version of this paper was presented at the American Educational Research Association in the symposium "The Role of Formative Research as a Bridge Between Developers and Software Users," San Francisco, CA, March 28, 1989.

kinds of formative questions from those explored during the early phases of the development process. While it can expand upon some of the fine-grained inquiries about exactly what students learn from the experience (e.g., how does the process of using a piece of mathematics software relate to individual students' development of insight into place-value), without a large budget and long timeline, this is often not the best context to address those categories of formative questions. Situated research, however, can address questions concerning how the educational technology functions within the complex environment of the classroom. More specifically, what are the occasions of interpretation and use that enable students and teachers to engage with educational technology in a productive way?

Within the framework of this paper we will discuss four issues that are central to situated research:

1. How is the prototype interpreted by teachers?
2. How does the prototype function as part of the ongoing content curriculum that is both the backbone of and the blueprint for classroom goals and activities?
3. How does the prototype function within the organizational context of the classroom?
4. Within the social context of the classroom, how is the prototype interpreted by students?

These questions address not just the issue of how a product *fits* into existing circumstances, but issues of potential *change* made possible by patterns of appropriation and use employed by teachers and students in relation to the prototype. Such identifiable patterns may be useful in facilitating our understanding of the ways in which different educational contexts can be modified to support creative and lasting practices for integrating technology in a deep and meaningful way. Research methods such as preliminary discussions with teachers, formal and informal interviews with teachers and students conducted throughout the research process, and observations of how teachers and students make use of the prototype materials are useful tools in examining the prototype in a situated research context.

We will illustrate each of the above questions by using examples from formative research we have done with two different prototype products: a computer-based set of interactive cognitive "tools" to support inquiry practices in science; and a television series that uses a narrative format to introduce students to different arenas of scientific and mathematical inquiry. The former prototype, *Inquire*, is illustrative of a case in which the developers and researchers had to make certain modifications in the software and the design of the field test. The later prototype, *The Second Voyage of the Mimi*, is an example of situated research under the most optimal circumstances—there was an ideal match between the developers' goals and the teacher's.

Inquire is a set of computer-based interactive cognitive tools to help middle-school students conduct inquiry projects in science. The tools provide structure and support for processes of question formulation and revision, for information finding and recording, and for interpretation of qualitative and quantitative information to solve problems. In the field test, an eighth grade class in a New York City public school worked with *Inquire* over a two-month period as part of their required science-project work. Students investigated a set of problems in sports physics, and were given a wide variety of materials in multiple media (video, computer simulations, and laboratory programs, as well as a variety of text resources and a human expert) as some of the source material for their investigations.

The Second Voyage of the Mimi is a federally funded multimedia project in science and math education for upper-elementary school students. The centerpiece of the *Mimi* is a 24-part television show that focuses on Maya archeology in the Yucatan Peninsula of Mexico. The story features a young boy and his grandfather who, through a series of coincidences, end up involved in an adventure that leads them into an extensive exploration of Maya life—both past and present. The situated research that we conducted with the video dramas took place over the course of several months in a fifth/sixth grade classroom in an alternative elementary school in East Harlem.

1. How Is the Prototype Interpreted by Teachers? In general terms, teachers interpret technological prototypes in relation to the following kinds of concerns: their educational goals and objectives; the fit between a particular problem situation and the technology; and their orientation to the value and function of technology within a classroom setting. Within the framework of situated research, it is the responsibility of researchers to take the concerns of teachers seriously. The result is that teachers become collaborators, giving shape and focus to the design of the research.

In discussions with the teacher, the *Inquire* field test was designed to fit into the science research project work that was required of students in the spring semester. The developers' goals were to see how the procedures supported students' thinking and their use of a variety of content materials. The teacher's primary goals, however, were slightly different. He was more interested in how the technology could provide an occasion for talking about and practicing the social skills involved in small-group, collaborative work on a science project. He wanted to use the system to make very explicit the processes groups must engage in (e.g., brainstorming, how to exchange information if students work on different parts of the problem), and to consciously demonstrate and practice these group process skills. He, skeptically, wanted to see if the technology could play a substantial role in addressing this difficult problem. The design of the field test was altered somewhat to accommodate this goal, and the results indicate that the interactive procedures made explicit by the tools successfully engaged students in a new way in small-group investigations.

With *The Second Voyage of the Mimi* materials, we were invited by the teacher to use his classroom as a site for formative evaluation. His students were in their first month of what was to be a year-long investigation of Maya culture. He saw the dramatic videos as a way to supplement and enhance an investigation that was already under way. He chose to use the videos as a jumping-off point with which to corroborate and expand upon issues already under discussion. As researchers, we were able to accumulate a wealth of information on the creative use of these materials and to incorporate this information into the design of the accompanying print materials.

2. ***How Does the Prototype Function as Part of the Ongoing Curriculum?*** If the technology does not connect substantively with the ongoing work of the classroom, then it will always be peripheral, regardless of the good intentions of the developers. Ideally, the product should be flexible enough so that it can be used in a variety of classroom settings. Previous research and development must have been "good enough" to ensure that the product can accommodate a wide range of anticipated users. Using the context of situated research, the evaluator, in collaboration with the teacher and the students, must help to discover the conditions for that substantive connection.

Since *Inquire* is a set of content-free tools, the trick was to see how it could become integrated into the ongoing science curriculum—in this case "energy." The developers were dedicated to the notion that student inquiry work should grow, at least in part, from their own interests—no easy task when the focal content area for the development work was physics, and we wanted to substantially involve girls. Through previous formative research, we found that the topic of sports physics was quite motivating to students of this age, including a comfortable number of girls. Accordingly, the teacher chose to highlight this as the area for students' science projects. The development team found and developed a range of multimedia materials for students to work with—new to this classroom—and the teacher chose consciously to build bridges between the physical science information he formally presented and students' project work. We developed a mode of working where we *discovered* quite concretely what needed to be negotiated to integrate these tools into the content curriculum. The study provided a great deal of information about the kinds of content materials for student projects that work in conjunction with more formal curriculum presentations and that might be included in "content" disks that accompany the general inquiry tools.

The situated research conducted with the *Mimi* materials made it all the more apparent that students' understanding of the material contained in the video was greatly enhanced when their viewing was supplemented with ongoing projects and additional investigations. As part of their course of study, students were required to carry out projects on particular aspects of Maya culture that captured their imagination. Students chose a variety of activities, including learning to read Maya hieroglyphs and making a quilt that used the glyphs to tell a story; carrying out an investigation of the Maya number system; building Maya temples; making a clay map of the region the Maya lived in; and writing stories about the ancient Maya. At the end of the year, the students wrote and produced a class play, called "Vacation with the Maya," that dealt with the world of both the contemporary and ancient Maya as seen through the eyes of two young students from East Harlem.

3. ***How Does the Prototype Function within the Organizational Context of the Classroom?*** Within the social and intellectual context of a classroom, there is a complex stream of activity taking place that differs

significantly from laboratory settings and meeting rooms where initial formative testing is frequently done. The introduction of educational technologies into the classroom setting can potentially impact upon as well as be affected by the organizational environment. On the one hand, researchers may find that the prototype is used in ways they had not anticipated; on the other, researchers may observe that the prototype supports organizational practices that had not previously been in use (Martin, 1987). This information becomes important in the design of print materials that can support the creation of different learning contexts.

As discussed above, the teacher interpreted the primary power of *Inquire* to be explicit procedural support for small-group work. Through the field test, he found that his role changed in relation to this work organization. Before the software, he found that he spent much of his time explaining inquiry procedures to students, reminding them to take notes, and so forth. The software took over this low-level work by simply providing the activity framework to which students responded. This allowed the teacher, in his words, to "up the ante" of his involvement with students. He now had the time to give the "metacognitive" support necessary to complex problem solving: to remind individual students of the big picture of the problem when needed, to help them interpret their information, and to arrange for groups productively to exchange information at appropriate junctures.

The class using the *Mimi* materials had in place a practice where they gathered, "town meeting style," for approximately one hour each day. This format was used as an occasion to work on group process. Students were encouraged to listen to each other and understand that individuals' interpretations may vary depending upon their particular cultural backgrounds. The *Mimi* materials were incorporated into this ongoing activity. For several months, the town meetings centered around the video materials, and discussion and debate took place after the airing of each drama. Because the *Mimi* materials are about exploring, interpreting, and understanding another culture, the teacher was able to use the videos as an occasion to support and enhance a process that was already in place.

4. Within the Social Context of the Classroom, How Is the Prototype Interpreted by Students? In the typical formative setting, students frequently engage with prototypes out of the classroom context. They are often asked to interact with the materials as isolated individuals or as isolated pairs—not as members of a preexisting group. When a prototype is introduced into a classroom setting, students will interpret it depending upon what they think its purpose is in relation to what "counts" within the school environment. Thus, the way in which the prototype meshes with the dominant discourse of the classroom can make all the difference in how students view the materials.

In the *Inquire* classroom, issues of the legitimacy of this work arose pretty quickly—who were these people and why was all this discussion of group work processes going on? The larger framework of their required science projects helped students to see the place of the software in classroom activity and how it might actually be useful to them; they also really liked the fact that computers were now central to their science work. However, students struggled with the novel nature of these science projects they were being asked to do; some viewed this kind of information-finding-and-integrating inquiry like the research they did in history and nothing like the science projects they had done in the past. The foregrounding of group work processes was also a new and questionable activity to students, and the teacher found extra sessions to be necessary to help students understand how all the new pieces fit together. Students' interpretation of the field-test activity was essential to investigate because, in creating a print context and introducing the software, successful integration requires an understanding of how students define legitimate science project work—where do they put their efforts?

For the students in the class in East Harlem, the *Mimi* dramas became an important part of their classroom culture. On the one hand, the materials were highly effective in bringing to life the students' investigations of Maya life. On the other, the characters in the dramas provided an occasion in which meaningful identifications could take place and, as a result, students became invested in the struggles and concerns of the protagonists. In this respect, the connection to the *Mimi* materials was both intellectual and personal and, ultimately, much more meaningful to the students.

Several conclusions can be drawn that summarize the importance of conducting research within the ongoing framework of the classroom.

First, because situated research is carried out at the end of the development process, the prototype must be robust enough to function without too many problems; it cannot be substantially revised at this late phase of development. However, minor changes can be made that can significantly affect the ways in which students interact with the product and/or understand it. In the case of *Inquire*, we were, for example, able to insert procedures that allowed kids to identify their own work when working with others in a small-group context. In the case of the *Mimi* dramas, we were able to inform the production staff that the episode which contained a lesson on Maya math was enormously confusing to kids; as a result the producers re-shot that segment.

Second, the information collected in a situated research setting can have an enormous impact on the design and development of the accompanying materials. With the *Inquire* program, we were interested in developing content disks, which would accompany the general tool. The work that the students did in sports physics provided us with a wealth of relevant information about the kinds of materials that work in that and, by implication, other domains. In the case of the *Mimi* research, at the conclusion of the academic year the teacher was hired by the development staff to write the teacher's guide for the video dramas. He was able to effectively incorporate into the guide the information that he had accumulated in the course of using the materials.

Third, if we have as our overriding goal the deep and meaningful integration of information technologies into the framework of existing classroom activities, then it is essential to understand the multiple ways in which this can happen. As researchers we can document the factors that lead to both successful and unsuccessful experiences in situated research settings. We can use the information collected in a variety of classroom contexts to help us identify the variables that lead to successful models for technology integration. In this respect, classroom formative tests become a source of interesting information that can be accumulated over studies and applied as a body of knowledge to new product development.

If we are to take seriously the task of understanding how technology can be integrated into classroom settings, we need a flexible approach that can accommodate the nuances of various classroom environments. Most important, we must listen to the needs of teachers and students and enlist their support as collaborators and shapers of the research process.

Notes

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